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## TAX INCIDENCE IN AFRICAN ECONOMIES EVIDENCE FROM COTE D'IVOIRE

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**TAX INCIDENCE IN AFRICAN ECONOMIES:  
EVIDENCE FROM COTE D'IVOIRE\***

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### **Tax Incidence in African Economies: Evidence from Cote d'Ivoire**

**Ngee Choon Chia, Sadek Wahba, and John Whalley**

#### **IRIS Summary**

This paper discusses tax incidence in African economies, reporting incidence results from a numerical general equilibrium tax model for Cote D'Ivoire. We argue that several special features of economic structure in Africa change perceptions on tax incidence compared to what is usually thought to be the case from better known incidence analyses in OECD countries.

Thus, with large interhousehold transfers (especially typical of West African economies), taxes which might traditionally be viewed as borne by particular household groups can be partially transmitted to other groups through tax-induced changes in transfers, changing overall incidence conclusions. Also, because of the narrow bases for the major taxes typically found in African economies (in the Ivorian case, export taxes on cocoa and coffee, income taxes effectively paid only on government employees), tax incidence effects in Africa tend to be concentrated more on socioeconomic or sectoral groups rather than on income ranges.

Instead of using a series of shifting assumptions on which to base tax incidence analysis, the model uses a numerical general equilibrium model which allows us to incorporate those specific features of structure into the model which will affect tax incidence analysis. The model captures the main elements of the economy: production side (represented by seven tradable and eight nontradable sectors), households (combined according to seven socioeconomic groups), government

sector (which includes the public enterprises), and the rest of the world.

The conclusion offered is that for these economies, country-specific features need to be incorporated in any tax incidence analyses performed, and mechanical transfer of OECD-style tax incidence analysis can be misleading.

## I. INTRODUCTION

This paper discusses tax incidence in African economies, using Côte d'Ivoire as an example, arguing that several special features of economic structure in Africa change perceptions on tax incidence compared to what is usually thought to be the case from better known incidence analyses in OECD countries.

Thus, with large interhousehold transfers (especially typical of West African economies), taxes which might traditionally be viewed as borne by particular household groups can be partially transmitted to other groups through tax-induced changes in transfers, changing overall incidence conclusions. Also, because of the narrow bases for the major taxes typically found in African economies (in the Ivorian case, export taxes on cocoa and coffee, income taxes effectively paid only on government employees), tax incidence effects in Africa tend to be concentrated more on socioeconomic or sectoral groups rather than on income ranges. Hence, concentrating on effects by income range in tax incidence analyses for such economies may miss larger redistributions taking place elsewhere. Finally, in the heavily trade-restricted environment common in these economies, changes in trade-related taxes (tariffs, export taxes on commodity producers) can have especially large incidence effects.

We use a numerical general equilibrium model of Côte d'Ivoire which incorporates these and other characteristics common to other African economies, and which allows us to compare results of incidence analyses with and without such

specific features.<sup>1</sup> Results show how these features change tax incidence conclusions relative to conventional tax incidence analysis.

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<sup>1</sup> For a full discussion of the model structure see Chia, Wahba and Whalley (1992).

## II. A GENERAL EQUILIBRIUM MODEL OF THE CÔTE D'IVOIRE FOR TAX INCIDENCE ANALYSIS

### *The Côte d'Ivoire Economy and Tax System*

Côte d'Ivoire is a mid-sized middle-income African economy, with a population of 12 million (1989) and income *per capita* of approximately \$800 (\$740 in 1990). It is also a central member of the West African Monetary Union (Union Monétaire Ouest-Africaine-UMOA)<sup>2</sup>.

In the first two decades following independence, the Ivorian economy experienced rapid growth in both output and exports. But in the second half of the seventies, a number of shocks disrupted the economy and growth rates began to fall. Although there was an improvement in performance between 1984-1986, following a rise in world prices of coffee and cocoa and an appreciation of the dollar, from 1986 on earlier declines in real output accelerated, with real GDP falling by more than a quarter.

The tax system in RCI has undergone substantial change over these decades. Both government expenditures and revenues grew in the 1960s as commodity exports grew, because of the pre-eminent role of trade taxes (both export taxes and import duties). But as small scale manufacturing developed, with urbanisation and an expansion of government employment, personal income taxes (largely on government employees), and corporate taxes (heavily on foreign-owned subsidiaries) began to

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<sup>2</sup> Côte d'Ivoire accounts for approximately 40 percent of the Union's GDP and a quarter of Union population, and shares a common freely convertible currency with other Union members. The UMOA includes six other countries: Bénin, Burkina-Faso, Mali, Niger, Sénégal, and Togo.

grow. Indirect taxes also became more important. Today a manufacturing level VAT<sup>3</sup> operates as a major government revenue source alongside specific excise taxes on gasoline, tobacco, liquor, and other items. The tax system in Côte d'Ivoire has traditionally been viewed as substantially biased against exports. In 1986, export taxes and contributions to the Caisse de Stabilization (the commodity price Stabilization Fund) provided almost 17 percent of total taxes collected.

### *Incidence Analysis*

Studies of the redistributive effects of taxes for various economies around the world<sup>4</sup> typically involve numerical calculations of annual tax incidence based on assumptions (or model-based treatments) as to how components of tax systems are shifted<sup>5</sup> onto consumers, producers, owners of assets, and other agents. They typically use annual data and focus on five key tax groups: personal income, corporate, sales and excise, property, and social security taxes. In these analyses, each tax has sources and/or uses side effects. Numerical general equilibrium models are the main tool used in such analyses [see Shoven and Whalley (1972, 1984)].

Three main income sources are assumed to potentially bear the burden of taxes in such studies: capital income, labour income, and transfers. Transfers are heavily

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<sup>3</sup> See the more detailed discussion of the VAT in Côte d'Ivoire in Heian and Monson (1987).

<sup>4</sup> See, for instance, Gillespie (1980), Pechman and Okner (1974), Musgrave, Case and Leonard (1974), Browning (1978), Whalley (1984), and Shah and Whalley (1991).

<sup>5</sup> In the literature the terms 'shifting assumptions', 'incidence assumptions' and 'sources and uses side effects' all refer to procedures used in the allocation of tax burdens. These terms are used interchangeably here, although we predominantly use the term 'shifting assumption'.

concentrated in the lower tail of the income distribution, capital income in both the upper and lower tails (owing to the presence of retirees), while labour income is closest of the three to being proportional to income. Thus, depending upon whether the sources side effects of a tax apply to capital income, labour income, transfers, or income in general, progressive or regressive incidence can result. A key element underlying uses side effects in these studies is differential savings rates by income range. In OECD countries, typically around 40 percent of household savings is concentrated in the top 10 percent of the income distribution, and hence taxes that are treated as borne by consumers of taxed products produce regressive incidence effects.<sup>6</sup>

In these studies, the income tax is usually treated as paid by income recipients and is progressive due to increasing average tax rates. Social security and related contributions are treated as payroll taxes on labour and, outside of the lower tail of the income distribution, are regressive due to the ceilings on contributions. Corporate and property taxes are regressive if assumed shifted forward to consumers, while progressive if assumed shifted backwards to recipients of capital income. Corporate taxes are even more progressive if assumed borne by capital income specific to taxed industries rather than capital income in general, because of light tax treatment of widely held housing capital. In some literature, this motivates the use of dividends rather than all capital income (which includes dividends) as a more progressive distributive series for allocating corporate taxes. Sales and excise taxes are regressive

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<sup>6</sup> This is the case with the conventional treatment of sales and excise taxes. Uses side effects can also occur which are product specific, such as with excise taxes on alcohol and tobacco.

if borne by consumers, and progressive if borne by recipients of factor incomes.

Studies of tax incidence for developing countries, by and large, adopt the same shifting assumptions as in developed country incidence analyses, but are more typically performed on a tax-by-tax basis rather than for the whole tax system.<sup>7</sup>

Studies generally find the tax overall system to be broadly progressive (pro-poor), showing either a U-shaped [see, e.g., Malik and Saqib (1989) for Pakistan], or a progressive incidence pattern [see, e.g., Jayasundera (1986) for Sri Lanka].

Exceptions to this include Wasylenko (1985) for Jamaica, who finds an inverted U-shaped incidence pattern for the overall tax system, implying that the tax system redistributes from the middle income groups to the poor and the rich. There are relatively few studies, however, for African economies, and none of these emphasize the specific features of economic structure central to tax incidence results, since the same approach as in developed OECD countries is used.

#### *A General Equilibrium Tax Incidence Model of Côte d'Ivoire<sup>8</sup>*

Rather than simply using a series of shifting assumptions on which to base tax incidence analyses for African economies, we use a numerical general equilibrium model which allows us to incorporate those specific features of structure into the

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<sup>7</sup> A few recent studies have examined developing country tax incidence using general equilibrium techniques (see e.g., Habito (1984), Bovenberg (1988), and Chowdhury (1990)), although the important country-specific features of individual developing countries which we stress in this paper do not receive any significant attention in this work.

<sup>8</sup> A more detailed technical presentation of this model can be found in Chia, Wahba, and Whalley (1992).

model which will affect tax incidence analysis<sup>9</sup> We use an open-economy numerical general equilibrium tax model of Côte d'Ivoire to illustrate our approach.

The model we use captures the main elements of the economy for Côte d'Ivoire: producer and household behaviour, the government sector (which includes the public enterprises), and the rest of the world. It also captures interhousehold transfers, consumer groups identified by socioeconomic groupings rather than by income ranges, and trade taxes. The institutional setting within which tax policy is conducted is also reflected in the model by a wider notion of the fiscal system than is usual, capturing stabilisation of domestic producer prices through the Stabilisation Fund, and government-household transfer mechanisms.

Appendix A provides a formal algebraic presentation of the model; in this section we limit ourselves to a verbal summary of its main elements. The model is calibrated to a 1986 Benchmark Equilibrium Data Set for Côte d'Ivoire, and uses Cobb-Douglas and CES functions and literature-based elasticity estimates.

### ***Production***

The production side of the model includes 7 tradable and 8 non-tradable sectors. Tradables include: the food crop sector, the traditional export sector, the non-traditional export sector, the food processing sector, and the manufacturing sectors. Non-tradables include: gas and electricity, construction, transport, financial services, government services and other services. Given the importance of agriculture

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<sup>9</sup> A more detailed description of the model structure and its implementation is given in Chia, Wahba, and Whalley (1992).

in Côte d'Ivoire, (46 percent of GDP, and 91 percent of exports in 1986), more detail is incorporated for the agricultural than other sectors. We disaggregate this into the food crop sector, the traditional export sector (which includes coffee and cocoa), and the non-traditional sector (e.g., sugar, palm oil, rubber). The model also incorporates a distinction between formal and informal sectors; the informal sector includes as activities underrepresented in the annual financial survey of enterprises, and those that do not pay taxes or receive subsidies [Chia, Enoh, and Wahba (1991)].

In the model, all sectors are assumed to be competitive, with labour mobile across sectors. Production functions for each sector are nested, the top level being a Leontief function over intermediate inputs and value-added; intermediate demands, in turn, being a CES function of domestically produced and imported goods; and value-added being a nested CES function over capital and labour, the latter being further disaggregated by labour type. Two model variants with differing treatments of capital are used: with capital immobile (reflecting the short run), and also mobile (reflecting the longer run). In both variants capital is also assumed to be internationally immobile. In all variants, firms determine factor demands and output supplies by maximising profits.

### ***Households***

Unlike in tax incidence studies where households are grouped according to income range, households in the model are stratified by socioeconomic group. The seven household groups are export households, food crop households, households in

the Savannah region, households who are administrative government employees, households in the formal sector, households engaged in independent trades or in the informal sector, and inactive households.<sup>10</sup> These groups are listed in Table 1, along with data on household group characteristics including shares of population, per household income, savings rates, and net transfers paid or received. Classifying households in this manner thus allows us to identify the impacts of alternative tax arrangements on different groups of the economy.

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<sup>10</sup> See Chia *et al.* (1991) for a more detailed discussion of this household classification.

**Table 1**  
**Key Characteristics of Ivorian Household Groups**  
**Identified in the Tax Incidence Model**

Household Types	% of Total Population	Poverty <sup>11</sup> index (%)	Per Capita Income (CFA)	Savings as % of total income	Income tax as % of total income	Transfer payments to other households (as % of total income)	Transfer income received from other households (as % of total income)
Food Croppers in Savannah	11.03	63.68	132,972	0.33	0.80	0.00	24.00
Export Croppers	20.28	44.04	173,722	0.57	0.50	15.60	0.00
Small Businesses	21.48	46.81	187,600	0.91	1.02	0.00	0.00
Other Food Croppers	12.77	34.46	202,176	0.37	0.45	32.75	0.00
Inactive	15.10	37.07	220,629	0.75	2.81	0.00	67.86
Government Employees	11.80	8.69	423,085	0.89	5.86	11.24	0.00
Households in Formal Sector	7.60	1.79	622,807	0.80	2.48	16.96	3.50

<sup>11</sup> This index indicates the fraction of the household population within each cell who are below the official poverty line.

Households maximize utility subject to a budget constraint; nested functions are again used. At the top nest, a Cobb-Douglas function is defined over goods (outputs of the 15 sectors). At the lower nest, a CES aggregation function is defined for traded goods over domestic and imported goods. In the static model, household shares of consumption and savings in post-tax income are constant, and household utility maximization is over the 15 model goods subject to a net of savings budget constraint. All household savings are thus treated as being paid into a savings pool which finances domestic investment. Investment expenditures, in turn, are fixed shares over the 15 goods. Each household thus consumes the 15 types of consumer goods identified in the model, is endowed with an exogenous and fixed amount of both mobile factors (labour and capital) and sector-specific factors, and has preferences, which also differ by household.

Besides income from endowments, households also receive transfers from the government, from abroad and from other households, and unlike in OECD countries, these interhousehold transfers play a major role in economic activities. Data on these transfers are shown in Table 1. These are estimated using information from the Living Standard Measurement Survey (LSMS) for Côte d'Ivoire on total household outgoings, as well as household data on financial savings. The difference is taken to be net transfers, which in the model are constrained to sum to zero<sup>12</sup> across all household groups.

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<sup>12</sup> For a similar approach see Pyatt and Round (1985).

We model each bilateral interhousehold transfer as a fixed proportion of the net-of-tax income of the donor household.<sup>13,14</sup> Table 1 indicates the level of transfers for recipient and donor households, as well as the share in total income. Cox and Jimenez (1990) survey the size of household transfers in various developing countries and show that in general the magnitude of these transfers is large. The level of transfers reported in Table 1 by group is generally not that different from estimates reviewed in Cox and Jimenez (1990).

### *Labour Market*

The model also includes a treatment of the labour market which is a little more detailed than in other developing country general equilibrium models. To capture labour market segmentation in Côte d'Ivoire, labour is disaggregated into three types: agricultural, skilled, and unskilled labour. Skilled and unskilled labour move freely across sectors, while agricultural labour is sector specific. In the agricultural sector, unskilled labour, skilled and agricultural labour enter a CES aggregation function. In the non-agricultural formal sectors, labour is a nested CES function of skilled and unskilled labour. The informal sector only uses unskilled labour.<sup>15</sup> With unskilled

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<sup>13</sup> The literature on risk sharing in rural sectors in developing economies [see Alderman and Paxson (1992)] treats inter-household transfers alternatively as a form of consumption smoothing across households. The origins of this literature can be traced back to the work of Arrow and Hahn (1971).

<sup>14</sup> The way transfers are modelled in the paper does not, therefore, distinguish between motives for remitting, which in the context of Côte d'Ivoire are mostly related to migration patterns. Lucas and Stark (1987) analyze various motivations for remitting generated by migration flows in the case of Botswana.

<sup>15</sup> For a more detailed description of this structure, see Chia *et al.* (1992).

and skilled labour mobile across sectors, this treatment of labour markets captures movements between formal and informal sectors, as well as migration between agricultural and non-agricultural sectors (i.e., rural-urban migration).

### ***Government***

In the model the government provides various services to the public free (or with a small user fee), such as public administration, economic and social planning, defence and security services. Levels of provision are decided upon through government utility maximisation defined over inputs (mainly labour) used to provide these services; i.e., there is no mechanism for households to articulate demands for public goods.

In addition to real goods and services used by government to provide public services, public sector transfers to households for education and other purposes also appear in the model. These government activities are financed by the taxes which are explicitly modelled and whose incidence effects provide the subject matter for this paper. Finally, the government sector also includes the Caisse de Péréquation (Marketing Board for rice) and Caisse de Stabilization (Marketing Board for cocoa, coffee), whose activities are modelled as tax or subsidies depending upon whether or not revenues are raised by the fund on a net basis.

### *External Sector*

The external sector in the model reflects the Armington (1969) assumption that imports are imperfect substitutes for comparable domestically produced goods. The model assumes small open price taking behaviour for both imports and exports, and exported products are treated as homogenous across domestic and foreign markets. Domestic-import composites enter both intermediate demands and household final demands. Tariffs apply to imported products.

### *Numerical Calibration and Implementation of the Model*

The model is specified using the calibration procedures outlined in Mansur and Whalley (1984). We use a benchmark equilibrium data (BED) representing the Ivorian economy for 1986.<sup>16</sup> The BED is used to calibrate a basic variant of the model, and then other variants to be used in sensitivity and other analyses. It also provides a benchmark for counterfactual analysis with the model. The model structure used in the central case variant of the model is summarized in Table 2.

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<sup>16</sup> 1986 was chosen because it was the most reliable national accounts data available at the time the model was constructed (i.e., final accounts rather than provisional accounts), as well as having an Living Standard Measurement Survey (LSMS) [see Chia *et al.* (1991)]. 1986, however, is a year in which the Stabilization Fund raised significant net revenues (i.e., acted as a tax), unlike the late 1980s and today.

Table 2

**Specification for the Central-Case Variant  
of the Côte d'Ivoire Model**

**A. PRODUCTION**

- 15 sectors
- nested CES functions
- Leontief function of value-added and intermediate inputs
- Value-added CES function over capital and labour inputs
- Intermediate demand a CES function of domestically produced and imported products
  
- 2 categories of capital
- non-agricultural capital - fully mobile
- Sector-specific agricultural capital
  
- 3 labour types
- skilled labour
- unskilled labour in agricultural sector
- unskilled labour in non-agricultural sector

**B. CONSUMPTION**

- 7 household types
- CES utility function defined over composite domestic-import traded goods and non-traded goods

**C. ADDITIONAL FEATURES**

- inter-household transfers
- small open price-taking economy
- Armington assumption; i.e., similar domestically produced and imported goods imperfect substitutes

#### IV. TAX INCIDENCE RESULTS FROM THE CÔTE D'IVOIRE MODEL

Table 3 reports incidence results for various components of the Côte d'Ivoire tax system using 1986 data, and the central case specification of the model. In each incidence experiment, we substitute a yield-neutral broadly based sales tax for components of the tax system, with total real government revenues (and hence expenditures) kept constant in real terms (differential incidence analysis in the sense of Shoven and Whalley (1977)). For each household group, we report welfare impacts in terms of Hicksian equivalent variations expressed as a fraction of the base-case gross income of the household group by household for the tax change involved. A positive number indicates a gain, and a negative number a loss from the change in the present tax regime to one with an equal-yield broadly based sales tax in place of the replaced tax. We analyze the effects on the seven household groups in the model, ranked from richest to poorest.<sup>17</sup>

##### *Incidence Results by Tax*

Results in Table 3 generally suggest a progressive incidence profile for the Ivorian income tax, but not for the top income group in the formal sector, where use of tax loopholes and avoidance devices changes the incidence profile. Other

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<sup>17</sup> Note, however, that this classification from poor to rich is not identical to what would be used in a more traditional income range tax incidence analysis, since the use of socio-economic criteria rather than income deciles means that the poor and the rich households in the economy are distributed across all of these groups. The poor-to-rich household ranking in Table 4 is by the mean incomes of each group.

Table 3

**Incidence Effects of Ivorian Taxes from the Central Case Model Variant**  
**(Hicksian EVs expressed as percentage of benchmark gross income)**

Households	Introducing an equal yield, non-distorting consumption tax to replace:					
	Personal income tax	Production taxes	Export taxes	Import duties	Stabilization Fund	Subsidies
	1	2	3	4	5	6
Poor ↓ Food croppers in Savannah	-0.65	-6.44	0.25	0.67	0.46	-3.58
Export croppers	-0.26	4.51	1.12	24.11	27.87	0.86
Small businesses	-1.58	1.24	0.09	-0.18	-1.60	0.22
Other food croppers	-1.52	-7.93	0.04	0.16	-3.03	-3.20
Inactive	2.66	-2.53	0.42	1.12	5.35	-2.79
Government employees	3.44	2.59	-0.61	-8.50	-10.33	1.52
↑ Rich Households in formal sector	-0.63	3.48	-0.38	-10.80	-8.73	1.73

developing country incidence studies using partial equilibrium generally show personal income taxes to be progressive, since these taxes are assumed to be borne by those individuals who pay them. These studies ignore complications stemming from effects on labour migration or tax evasion, and interhousehold transfers which (as is shown later) can alter the incidence profile.

Column 2 in Table 3 presents incidence results for production taxes, finding their incidence profile to be neither progressive nor regressive, with the major effects operating against the non-export agricultural sector (food croppers in the Savannah, and other food croppers), and with exporters and urban dwellers gaining from the removal of the tax (and its replacement by a yield-neutral alternative). A series of factors account for these results. Food croppers are largely tax free in the base-case situation, and are adversely affected by the broadly based equal-yield tax which they, along with all households, pay. Urban dwellers are heavy payers of the manufacturing level VAT in Côte d'Ivoire.

These results also differ from those in other incidence analyses of production taxes in developing countries, which generally reflect an assumption of full forward shifting. Because these taxes are usually simply allocated among income ranges using data on consumption expenditures in earlier studies, they usually find that these taxes are regressive, while also arguing that this regressivity could be reduced through the use of differential tax rates by commodity, and excises on luxury goods. Here, the incidence profile is a mix of negative and positive effects by household group. Larger redistribution occurs than with the income tax because of the large relative

price effects stemming from removal of selective sales taxes, including the VAT and border tax adjustments.

Incidence results for export taxes in Table 3 show a pro-poor effect from the removal of export taxes, suggesting that these taxes are regressive. In part, these incidence effects in model results reflect the fact that replacement taxes also apply to urban households consuming imported products. These results also stand in contrast to those from other incidence studies which assume that the incidence of export taxes falls exclusively on producer-exporter groups, and which yield a progressive incidence pattern, since these groups are in the higher income ranges. One study consistent with these findings is that of Sri Lanka by Jayasundera (1986) who also considers implicit subsidies to domestic consumers associated with export taxes on tea and rubber, and finds that these have pro-poor incidence effects.

Results in Table 3 also suggest that incidence effects of import duties in Côte d'Ivoire are large, with mixed effects across household groups ranked by income range. Removing duties positively and substantially affects agricultural export sectors, since import duties operate akin to export taxes. Since prices of domestic import competing products are raised by the tariff, removing tariffs raises domestic prices of exportables relative to import substitutes, which affects returns to fixed factors in export sectors. Subsistence food croppers selling food products to the domestic and urban market suffer, as agricultural wages are bid up by agricultural exporters. Government workers lose since they must pay the new replacement tax. In other developing country incidence studies, import duties are usually assumed to be

fully forward shifted to consumers of imported products, with a regressive or proportional incidence outcome the standard result [see Jeetun (1978)].

Large incidence effects are also revealed by results in Table 3 for the Stabilization Fund covering coffee and cocoa. The gain to export croppers from removing the 1986 tax is nearly 30 percent of income. Interestingly, inactive households share in this gain due to the large interhousehold transfers operating in Côte d'Ivoire. Government employees and households in the formal sector lose due to the introduction of the yield-neutral alternative tax which they must pay. In part, these results are a reflection of the 1986 base-year data used in the model, since in this year large net receipts accrued to the Fund which acted as a tax on export croppers. In the early 1990s, the Fund was close to break-even, if not a net payer of revenues, and hence in model terms its policies acted more like subsidies.

The elimination of subsidies, like other experiments considered in Table 3, has a mixed incidence pattern with both positive and negative effects across households. Food croppers tend to lose because of the direct benefits they forgo from agricultural and other subsidies; the inactive lose due to reduced inter-household transfers; and other groups gain due to reduced financing requirements (reflected in a replacement by a yield-neutral broadly based subsidy).

A theme that emerges strongly from all these results is that the Ivorian tax system has large redistributive effects, but they criss-cross the rich-poor spectrum of mean household incomes in a number of ways. Removing import duties substantially benefits export croppers. Government employees and formal sector households gain

from removing subsidies to the poor due to lowered taxes, and from removing progressive personal income taxes. Low-income food croppers lose from the effective broadening of the VAT base, and the removal of subsidies. And finally, given the 1986 data we use in which the Stabilization Fund appears as a tax, export croppers benefit from its removal, while higher income groups lose from the equal yield replacement tax introduced in its place.

Overall incidence effects are, thus, not graduated from rich to poor as is the case in OECD-style incidence analyses. Positive and negative signs alternately appear in incidence profiles as one moves from mean income poor to rich households. This is because, in contrast to developed countries, incidence effects by tax are more heavily concentrated on particular socio-economic groups than they are by income range.

### *The Role of Interhousehold Transfers*

An important feature of the model underlying the results reported in Table 3 is the presence of interhousehold transfers. As Table 1 suggests, they are large, and as a result taxes thought to be borne by one household group can be indirectly borne by others through reduced transfers. Table 4 thus reports incidence results for a model variant where all interhousehold transfers are treated as being paid directly to the government instead of other households. This is an artificial construct, but it removes the direct effects of interhousehold transfers on incidence results.

Compared to results in Table 3, incidence effects under this specification change sign for some household groups (such as the inactive) in the production tax case, and the general incidence picture is substantially different for each tax. The mechanism underlying these differences in results is that payers of transfers are little affected by the model modification, paying transfers in the central case model variant to other households and to the government in the new model variant. But receivers of transfers (such as the inactive) now receive a larger overall proportional share of government revenues, rather than directly from other households, substantially weakening interhousehold linkage in transfer activity and its influence on tax incidence results.

The differences in results between Tables 3 and 4 thus overemphasize the importance of interhousehold transfers in assessing the incidence of taxes in African economies such as Côte d'Ivoire, although a limitation of our analysis, as mentioned in Section 2, is that we fail to explain what motivates households to transfer these funds.

Table 4

**Incidence Effects of Ivorian Taxes When  
Interhousehold Transfers are Eliminated from the Model**  
(Hicksian EVs expressed as percentage of benchmark gross income)

Households	Introducing an equal yield, non-distorting consumption tax to replace:					
	Personal income tax	Production taxes	Export tax	Import duties	Stabilization Fund	Subsidies
	1	2	3	4	5	6
Poor ↓						
Food Croppers in Savannah	-1.17	-8.06	0.21	0.62	0.88	-3.97
Export Croppers	-0.05	3.99	1.20	24.43	29.43	0.36
Small Businesses	-1.63	1.26	0.08	-0.17	-1.40	0.24
Other Food Croppers	-1.25	-9.00	0.21	0.58	-0.49	-4.39
Inactive	0.16	0.61	0.07	-0.43	-1.36	0.06
Government Employees	4.62	2.10	-0.54	-8.13	-8.92	0.97
↑ Rich						
Households in Formal Sector	0.22	2.89	-0.29	-10.38	-7.06	1.06

## V. CONCLUDING REMARKS

This paper discusses tax incidence in African economies, reporting incidence results from a numerical general equilibrium tax model for Côte D'Ivoire. We evaluate incidence effects for various Ivorian taxes (as well as the whole tax system) using the model, and suggest important effects on incidence findings from large interhousehold transfers (taxes thought to affect one group also affect others through changed transfers); from taxes which are much more marked in their impact across socio-economic groups than income ranges because tax bases are narrow and largely sector (or group) specific. We also emphasize how tax burdens in African economies are potentially substantially affected by trade-related tax changes. The conclusion offered is that for these economies, country-specific features need to be incorporated in any tax incidence analyses performed, and mechanical transfer of OECD-style tax incidence analysis can be misleading.

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## APPENDIX A

## FORMAL PRESENTATION OF MODEL STRUCTURE

## 1. Production

Two levels of nesting are used. At the top level, producers in sector  $j$  use intermediate inputs ( $A_{1j}, \dots, A_{15j}$ ) and value-added ( $VA_j$ ) to produce output ( $Q_j$ ). A Leontief production function is used which combines intermediate inputs and value added in fixed proportions, implying that there is no substitution between intermediate inputs and value added.

$$Q_j = \min (A_{1j}, \dots, A_{15j}, VA_j) \quad j = 1, \dots, 15 \quad (A1)$$

A Leontief input-output technology is also assumed for intermediate demands.  $A_{ij}$  denotes the amount of intermediate input  $i$  used in sector  $j$  and  $a_{ij}$  is the intermediate input-output coefficient. The demands for intermediate inputs by sector  $j$  are:

$$A_{ij} = a_{ij} Q_j \quad i = 1, \dots, 15 \quad (A2)$$

This Leontief specification for intermediate inputs implies that demands for intermediate inputs depend only on technology (the  $a_{ij}$ ) and are independent of prices.

Each intermediate requirement  $A_{ij}$  can be met by using a substitutable mix of comparable imported ( $AM_{ij}$ ) and domestically produced goods ( $AD_{ij}$ ) represented by a CES function. If  $\sigma_{mj}$  is the elasticity of substitution between  $AD_{ij}$  and  $AM_{ij}$ ,

$$A_{ij} = \varphi_{A_j} \left[ \delta_j AD_{ij}^{(\sigma_{mj}-1)/\sigma_{mj}} + (1-\delta_j) AM_{ij}^{(\sigma_{mj}-1)/\sigma_{mj}} \right]^{\sigma_{mj}/(\sigma_{mj}-1)} \quad i=1, \dots, 15 \quad j=1, \dots, 15 \quad (A3)$$

## 2. Industry Value-Added Functions

Value-added in sector  $j$  ( $VA_j$ ), is a CES function of labor ( $L_j$ ) and variable capital inputs ( $K_j$ ). Labor and capital are treated as perfectly mobile across sectors, and capital is assumed to be internationally mobile.<sup>18</sup> If  $\varphi_{vj}$  is the CES function efficiency parameter;  $\delta_{kj}$  is the distribution parameter in the CES function for factors, and  $\sigma_{vj}$  is the elasticity of substitution between the factors, the CES function is given by:

$$VA_j = \varphi_{vj} \left[ \delta_{kj} L_j^{(\sigma_{vj}-1)/\sigma_{vj}} + (1-\delta_{kj}) K_j^{(\sigma_{vj}-1)/\sigma_{vj}} \right]^{\sigma_{vj}/(\sigma_{vj}-1)} \quad j=1, \dots, 15 \quad (A4)$$

## 3. Demands for Variable Factors

Factor demands are derived from cost-minimizing behavior, given the CES functions above.  $\pi_{L_j}^*$  and  $\pi_{K_j}^*$  represent the gross-of-tax prices of the inputs  $L$  and  $K$  respectively in sector  $j$ , given the net-of-tax prices,  $\pi_L$  and  $\pi_K$ . If  $t_{L_j}$  and  $t_{K_j}$  are the tax rates levied on labor and capital in sector  $j$ , then

$$\pi_{L_j}^* = \pi_L (1 + t_{L_j}) \quad j=1, \dots, 15 \quad (A5)$$

$$\pi_{K_j}^* = \pi_K (1 + t_{K_j}) \quad j=1, \dots, 15 \quad (A6)$$

Producers in sector  $j$  obtain their per-unit value-added factor demands by minimizing their after-tax factor cost subject to  $VA_j$  equalling unity. The Lagrangean for this problem is:

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<sup>18</sup> For the agricultural sector, in addition to variable capital, we also specify specific factors. This is necessary to avoid the problem of specialization, typical in a small open-economy assumption.

$$\mathcal{L} = \pi_{L_j}^* L_j + \pi_{K_j}^* K_j + \lambda \left[ 1 - \varphi_{vj} \left( \delta_{kj} L_j^{(\sigma_{vj}-1)/\sigma_{vj}} + (1-\delta_{kj}) K_j^{(\sigma_{vj}-1)/\sigma_{vj}} \right)^{\sigma_{vj}/(\sigma_{vj}-1)} \right] \quad (A7)$$

$j=1, \dots, 15$

The first order conditions yield derived demands for  $L$  and  $K$  in sector  $j$  per unit of value-added, represented by  $f_{lj}$  and  $f_{kj}$  respectively:

$$f_{lj} = \frac{1}{\varphi_{vj}} \left[ (1-\delta_{kj}) \left[ \frac{\delta_{kj} \pi_{K_j}^*}{(1-\delta_{kj}) \pi_{L_j}^*} \right]^{(1-\sigma_{vj})} + \delta_{kj} \right]^{\sigma_{vj}/(1-\sigma_{vj})} \quad j=1, \dots, 15 \quad (A8a)$$

$$f_{kj} = \frac{1}{\varphi_{vj}} \left[ \delta_{kj} \left[ \frac{(1-\delta_{kj}) \pi_{L_j}^*}{\delta_{kj} \pi_{K_j}^*} \right]^{(1-\sigma_{vj})} + (1-\delta_{kj}) \right]^{\sigma_{vj}/(1-\sigma_{vj})} \quad j=1, \dots, 15 \quad (A8b)$$

#### 4. Treatment of the Labor Market

The model structure includes a treatment of labor market which is more complete than in other general equilibrium models. There is explicit modelling of labor (see Fig. 1). In the agricultural sector,  $L$  is a CES function of agricultural labor ( $T_{AG}$ ) and a composite of skilled ( $T_{QA}$ ) and unskilled labor ( $T_{NQA}$ ). In the non-agricultural formal sectors,  $L$  is a CES function of skilled ( $T_{QA}$ ) and unskilled labor ( $T_{NQA}$ ). As for the informal sector, it only uses  $T_{NQA}$ . This more detailed treatment of the labor markets help to identify the effects of alternative policies on different

labor components and capture migration processes when the feature of urban-rural migration is incorporated into the model.

## 5. Demand

The demand side of the model reflects government expenditures and demands of the seven household groups. Each of the households has endowments and

nonfarmhousehold with fixed labor

Douglas function defined over the composite goods ( $G_i^h$ ). Different Cobb-Douglas parameters are specified to reflect the different preferences across households. Let  $\gamma_i^h$  be the share of good  $i$  in household  $h$ 's consumption of  $G_i$ ; and  $p_i(1+\tau_i)$  be the gross-of-tax price of  $G_i$  where  $\tau_i$  is the consumption tax on  $G_i$ .

The utility maximization problem for household  $h$  is to

$$\max_{\{G_i^h\}} U_1^h = \sum_{i=1}^{15} \gamma_i^h \log G_i^h \quad h=1, \dots, 7 \quad (\text{A11})$$

subject to:

$$\sum_{i=1}^{15} p_i(1+\tau_i)G_i^h = Y_d^h - P_s S^h \quad h=1, \dots, 7 \quad (\text{A12})$$

Where  $P_s S^h$  represents the saving of household  $h$ .

At the lower level in the nesting structure,  $\beta_{mi}^h$  is the CES weighing parameter on  $GD_i^h$  and  $GM_i^h$  and  $\sigma_{mi}^h$  is the elasticity of substitution between  $GD_i^h$  and  $GM_i^h$  for household  $h$ . At this level, the budget constraint for household  $l$  is:

$$\sum_{i=1}^{15} [p_d GD_i^h + p_m GM_i^h] Y_{id}^h \quad (\text{A13})$$

where  $Y_{id}^L$  is the disposable income of household  $h$  to be allocated to composite good  $i$ , which is obtained from the top level utility maximization exercise.

At the lower level, each household solves a maximization problem:

$$\begin{aligned} \max_{\{GD_i^h, GM_i^h\}_{i=l}^{15}} U_2^h &= U_2^h(GD_i^h, GM_i^h) \\ &= \left[ \beta_{mi}^h GD_i^h^{(\sigma_{mi}^h-1)/\sigma_{mi}^h} + (1-\beta_{mi}^h) GM_i^h^{(\sigma_{mi}^h-1)/\sigma_{mi}^h} \right]^{\sigma_{mi}^h/(\sigma_{mi}^h-1)} \end{aligned} \quad (A14)$$

$$p_{di} GD_i^h + p_{mi} GM_i^h = Y_{id}^h \quad (A15)$$

Solving this yields

$$GD_i^h = \frac{\beta_{mi}^h Y_{id}^h}{p_d^{\sigma_{mi}^h} [\beta_{mi}^h p_d^{\sigma_{mi}^h} 1^{-\sigma_{mi}^h} + (1-\beta_{mi}^h) p_m^{\sigma_{mi}^h}]} \quad (A16)$$

$$GM_i^h = \frac{(1-\beta_{mi}^h) Y_{id}^h}{p_m^{\sigma_{mi}^h} [\beta_{mi}^h p_d^{\sigma_{mi}^h} 1^{-\sigma_{mi}^h} + (1-\beta_{mi}^h) p_m^{\sigma_{mi}^h}]} \quad (A17)$$

Since we use continuous utility functions, market demand functions are also continuous in addition to satisfying Walras law. Aggregating across households' demands yields market demands.

## 6. Savings and Investment

As noted in the text, this is a static model so household savings are not a decision variable, with household  $h$ 's saving ( $S^h$ ) determined as a fixed portion of income. Under the model treatment, savings finance investment with  $S^h$  transferred to an investment mutual fund agent who then invests in newly produced capital goods. These expenditures correspond to the investment by all the branches identified in the social accounting matrix. Since these expenditures are financed by household's savings, investments are "savings-driven" in the model.<sup>19</sup>

## 7. Equilibrium Conditions in the Model

The model solves for equilibrium product and factor prices, activity levels and tax revenues that satisfy all the equilibrium conditions in the model. These cover demand supply equalities for goods and factors, and zero profit conditions for each sector. These conditions can be represented algebraically as follows:

i. Market clearing for all goods and factors:

$$\sum_{j=1}^{15} f_{kj}^* \leq \bar{N}_k \quad k=1, \dots, 3 \quad (\text{A18})$$

$$\sum_{h=1}^7 G_i^h + \sum_{i=1}^{15} a_{ij} Q_j \leq Q_j \quad j=1, \dots, 15 \quad (\text{A19})$$

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<sup>19</sup> For a discussion of the implications of various savings and investment closure rules, see Dervis *et al.* (1989), and Adelman and Robinson (1988).

ii. Zero profits conditions in all sectors:

$$(1-t_{pj})\pi_j Q_j = \pi_k(1+t_k)f_{kj}^* + \sum_{i=1}^{15} \pi_i a_{ij} Q_j \quad j=1, \dots, 15 \quad (\text{A20})$$

The key properties of equilibrium which follow from these conditions include budget balance for the household and government sectors:

i. Household budget balance:

$$\sum_{i=1}^{15} p_i(1+\tau_i)G_i^h + TP^h = \sum_{k=1}^3 \pi_k \omega_k^h + \alpha_h \Gamma + TR^h - S^h \quad (\text{A21})$$

ii. Government budget balance:

$$\sum_{i=1}^{15} p_i(1+\tau_i)G_i^g + S^g + p_\Gamma \Gamma = R \quad (\text{A22})$$

## 8. Glossary of Notation Used in Model Presentation

- $Q_j$  : output of sector  $j$
- $A_{ij}$  : intermediate inputs of good  $i$  used by sector  $j$
- $AD_{ij}$  : domestically produced intermediate inputs of good  $i$  used by sector  $j$
- $AM_{ij}$  : imported intermediate inputs of good  $i$  used by sector  $j$
- $\sigma_{mj}$  : elasticity of substitution between  $AD$  and  $AM$  in sector  $j$
- $\delta_j$  : distribution parameter in the CES function for intermediate inputs

- $a_{ij}$  : intermediate input-output coefficient defining the requirement of input  $i$  per unit output of sector  $j$   
 $VA_j$  : value added in sector  $j$   
 $\varphi_A$  : efficiency parameter in VA function for sector  $j$   
 $\delta_{kj}$  : input intensity of factor  $k$  in sector  $j$  in VA function  
 $\sigma_{vj}$  : elasticity of substitution between factors  $k$  in  $j$ th sector  
 $L_j$  : labor use in sector  $j$ , in service units  
 $K_j$  : capital use in sector  $j$ , in service units  
 $f_{kj}$  : use of the factor  $k$  to produce a unit of output in sector  $j$   
 $t_{k_j}$  : ad valorem tax rate levied on capital in sector  $j$   
 $t_{L_j}$  : ad valorem tax rate levied on labor in sector  $j$   
 $\pi_k$  : net-of-tax price received by owners of factor  $k$   
 $\pi_L$  : net-of-tax price received by owners of labor  
 $\pi_{kj}^*$  : gross-of-tax price of capital used in sector  $j$   
 $\pi_{Lj}^*$  : gross-of-tax price of labor used in sector  $j$   
 $T_{QA}$  : skilled labor  
 $T_{NQA}$  : unskilled labor  
 $T_{AG}$  : agricultural labor  
 $K_j$  : capital use in sector  $j$ , in service units  
 $\bar{N}_k$  : total endowment of factor  $k$   
 $U^h$  : utility function of household  $h$   
 $\gamma_i^h$  : share parameter of  $h$ 's consumption of good  $i$

- $\Gamma$  : total government transfer  
 $\alpha_h$  : proportion of government transfer to household  $h$   
 $\omega_k^h$  : share of household  $h$  in the endowment of factor  $k$   
 $Y^h$  : gross income of household  $h$   
 $Y_d^h$  : disposable income of household  $h$   
 $Y_{id}^h$  : disposable income of household  $h$  to be allocated to composite good  $i$   
 $\tau_h$  : marginal income tax rate on  $Y^h$   
 $S^h$  : savings of household  $h$   
 $TP^h$  : transfer payments (to the rest of the world and other households) made by  $h$   
 $TR^h$  : transfer payments (from the rest of the world and other households) received by  $h$   
 $\tau_i$  : ad valorem tax rate on  $G_i$   
 $G_i^h$  : household  $h$  consumption of Armington composite good  $i$   
 $GD_i^h$  : household  $h$  consumption of domestically produced good  $i$   
 $GM_i^h$  : household  $h$  consumption of imported good  $i$   
 $\sigma_{m_i}^h$  : elasticity of substitution between  $GD_i$  and  $GM_i$  for household  $h$   
 $\beta_{mi}^h$  : CES weighing parameter on  $GD_i^h$  and  $GM_i^h$